On the Phenomena exhibited by a Planet in its Transit across the Solar Disk, from Observations made by M. Ch. André.

By the Rev. S. J. Perry.

The results contained in this paper have a special interest at the present time, as the experiments were made with the direct view of securing accuracy of observation at the transit of *Venus* in 1882. We have but a short time for making all the necessary preliminary preparations for this, our only remaining chance of testing the value of the transit of *Venus* methods for determining the solar parallax, and it is, therefore, well to learn what is being done elsewhere both as a guidance and as a spur.

The expedition of the Italians to India in 1874 was undertaken mainly with the object of testing the spectroscopic methods of observing the coming transit, and the volume printed by Signor Tacchini shows the success of their endeavours, and serves as an admirable guide for those who would prepare themselves for a fruitful campaign in 1882. Last summer I found that my own spectroscopes gave very satisfactory results with one of the methods; and I purpose examining the others more in detail and under varying circumstances during the coming year.

The experiments of M. André are being made under the most advantageous circumstances. The splendid subterranean basement of the École Normale at Paris is placed at his disposal, and there, in a passage considerably more than 100 meters in length, he has established his apparatus. This consists of a model of the transit of an inferior planet; the planet being moved by clockwork, and passing across the bright field backwards and forwards, without the necessity of any personal adjustment, and registering each contact electrically on a chronograph. The bright field which represents the Sun is illuminated by a Drummond light, and as a supply of oxygen is always at hand, a special pipe having been kindly laid down by M. H. Ste. Claire de Ville from his chemical laboratory overhead, no delay or loss of time is ever experienced; an advantage that will be fully appreciated by those who have made similar observations in the open air, with the Sun itself as the source of light. Three telescopes are mounted at the distance of about 100 meters from the model, and the chronograph is established in an adjoining passage. The method of observing is too obvious and too familiar to need any explanation here. It will suffice to give at once the conclusions at which M. André has arrived, which I will take from a letter received from him towards the end of last month.

1. The bridge, black ligament, or black drop, as it is variously called, is a necessary phenomenon under certain circumstances, and not merely accidental. With an unchanging source of light of sufficient brilliancy the angular dimensions of

the ligament are inversely proportional to the diameter of the object-glass, and with an aperture of 5-inches, the drop is scarcely perceptible. Diaphragms should never be used when observing *Venus* in transit, as the apparent dimensions of the drop are augmented by any increase in the focal length.

2. It is always possible to get rid of the ligament, and reduce the phenomena to geometrical contacts, either

(*a*) by reducing sufficiently the intensity of the source of light, or augmenting the absorbing power of the dark-glass employed; or again

(*b*) by covering the object-glass with a network diaphragm, composed of rings alternately full and empty, and all very thin, but bearing a certain proportion to the focal length of the lens.

3. The defect of imperfect focussing has but little influence on the result, the phenomena changing little as long as a fair focus is obtained.

4. Atmospheric undulations, on the other hand, have a considerable influence. They tend to give the image of the planet every description of strange form, and to them are due the contacts at several points at the same time, of which so much has been said. These are entirely got rid of by coating one of the surfaces of the object-glass with a thin film of silver.

5. Even when the object-glass is so small, and the dark-glass so thin, that the ligament is still present, the observation may still by good training be made very precisely. One phase of the phenomenon is simultaneous for all apertures, and can be estimated without difficulty to within $0^s{\cdot}75$ for interior contact at ingress, and $1^s{\cdot}5$ at egress, thus leaving a probable total error of $2^s{\cdot}25$ in the observed duration of the transit.

6. In order to secure the solar parallax to within $0''{\cdot}01$, it suffices that the error in the duration of transit should not exceed 5^s; a small telescope may, therefore, serve to determine this parallax to within $0''{\cdot}005$. Halley was not then mistaken in his estimate of the great value of his method.

7. The above results agree perfectly with the theory of instrumental diffraction, and can be rigorously deduced from it. To effect this, it is only necessary to draw the geometrical phenomenon as it presents itself at the different epochs of the transit, and to measure the portion of the volume of the solid of diffraction comprised between *Venus* and the Sun's edge. M. André has made the calculations for the epochs 10^s, 5^s, 0^s, and from the beginning and end of the transit.

8. The phenomena are the same for *Mercury* as for *Venus*, but the magnifying power must be greater for *Mercury*, almost double.

The difficulties that have so far surrounded the observation of the transit of *Venus* have arisen mainly from the preconceived idea expressed in the sole word "Contact." The phenomenon could have been geometrical contact only in a restricted

number of cases; and certainly our best results are such remarks as those of F. Hell, when he describes the breaking of the bright line; his words are clear, frank, and precise.

Besides giving the telescope a sufficient aperture, the maximum amount of light should also be obtained. It would be well, therefore, if possible to determine accurately beforehand the exact thickness of dark-glasses most suitable for the observation of the coming transit of *Venus*, and this might be obtained experimentally at the previous transit of *Mercury*. This last question of the dark-glass, which seems hitherto to have been considered but of little moment, is in reality one of the most important conditions in the observation.

If I might add one remark to these useful conclusions of M. André, I should think it would be well to make experiments also as to the tint of coloured glass best suited for diminishing the light of the photosphere, without altering considerably that of the chromosphere, in order to give some value to the first external contact. Dr. Janssen has already shown us the feasibility of this plan, and demonstrated that the spectroscope is not required in order to see *Venus* on the bright background of the chromosphere.

On the Orbit of α Centauri. By A. Marth, Esq.

(*From a Letter to E. Dunkin, Esq., F.R.S.*)

At the close of the last meeting of the Royal Astronomical Society you proposed that I should furnish in writing the substance of some remarks on the Double Star *α Centauri*, which I had been permitted to address to the meeting just before.

Though it has been pointed out some years ago that the comes of *α Centauri* would reach its apparent periastre in the course of the year 1875; and though the great importance of securing series of good observations during the preceding and following years is recognised and appreciated by all who keep themselves informed on the subject of binary stars; there seems cause to apprehend that the observers in the Southern Hemisphere, who alone are favourably situated for making such observations, have persisted in their strange neglect of this the most interesting of all double stars. Thinking that it might do some good, and could do no harm, if the subject were brought before the meeting, and if the personal friends of the Southern observers were appealed to for their friendly assistance, I asked leave to occupy a few minutes before the adjournment with a short statement of the circumstances of the case, and to exhibit a diagram which would render any detailed explanation superfluous. In order to enable readers of this letter to reconstruct the diagram (and they will find it far more instructive and satisfactory if they themselves